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PASTURE IN RELATION TO CROPLAND

BY WALTER V. KELL [1]

IT was a relentless task, one long to be remembered, to tame the "wild prairie." No problem of grass then.

The task was started, the area of cultivated land grew and expanded to include almost every acre of plowable land. What appeared to be the problem at that time was solved and the plow had won. No sooner was the grass gone than the winds began moving, destroying, and drying out the mellow rich earth. Rains that fell on the bare ground were denied entrance into the soil; the water ran off, carrying with it the prize the plow had won.

Today one of the major tasks confronting the Soil Conservation Service is that of developing practical and economical methods by which a part of this land may be returned to the grass that once gave the soil its original structure and productiveness, grass to make and hold the soil and to provide profitable feed for livestock. This new problem is far more important and difficult than the first and its solution depends on a variety of factors. Climatic stability, seasonable rainfall, water supply for domestic and livestock use, physical and chemical characteristics of the soil, topography, location with reference to markets, density of population, economic pressure, the desire to make the farm a permanent place to live rather than a place from which to retire at the earliest opportunity—all these are important influences related to the solution.

People cannot live on grass alone, neither can they survive on a depleted soil, nor has any extensive area ever established a satisfactory agriculture on a system that is wholly a cash-crop system. To ensure permanently an abundant supply of the necessities of life requires the production of both cultivated crops and grass or pasture. The amount of each, or the balance that should be maintained between pasture and cultivated land, is the problem. It varies by area. Only a few short years ago the pioneer farmers, some of whom are still here, had the problem of subduing the native vegetation for the preparation of cropland. The soil was fertile and the grass was persistent.

Pasture, whether too much or too little in relation to cropland, has always been and probably will continue to be a problem on the individual farm. Especially is this true when it is the policy of the individual or society to exploit virgin soil fertility by producing those crops that manufacture it into marketable products as rapidly as possible without regard for the future. Cash grain crops and their attendant physical loss of soil by erosion deplete the plant-food resources rapidly; grass, on the other hand, not only holds the soil but also maintains and restores its fertility.

Pasture is a farm crop; it produces a good or poor return, as compared with the other crops, in proportion to the interest and attention it receives. Too often the average farmer does not select land for pasture but uses whatever is left after providing for the other farm crops. The best farm land is now productive because nature kept it in permanent wildlife pasture before other crops were grown. Grass, as any other crop, responds to favorable conditions and fertile soil. In the past it has been the greatest of soil builders and it will continue to restore and maintain the fertility of all potential productive cropland if given an opportunity. Usually there is some land on the average farm that cannot or should not be used for cultivated crops but can best be adapted for permanent pastures.

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There is danger of forgetting that grass is largely responsible for making the cropland productive. The farmer who will plan a long-time grass rotation, to permit all of his land to rest part of the time while it is seeded to grass and used for pasture, can maintain soil fertility more easily and effectively than the farmer who attempts continuous cash-crop production.

How does pasture, or the growing of grass, function in building soil? In the first place the soil must be stabilized and held in place before it can accumulate and retain fertility. It has been repeatedly shown that grass is one of the best soil stabilizers we have. At Zanesville, Ohio, the Soil Conservation Service experiment station found that bare ground in corn or fallow lost from 35.2 to 42.5 percent of the total rainfall, while bluegrass lost only 4.5 percent. It is interesting to note that the grass made possible the infiltration of practically all the rainfall. This fact, however, is not nearly so important as is the "holding power" of bluegrass or other grasses. Land in continuous corn, at this station, lost *59.6 tons* of soil per acre per year as a result of run-off, whereas grass lost only *100 pounds* of soil per acre. On the above basis the 7 inches of fertile topsoil, if planted to corn each year, would be completely gone in 19 years; and on the other hand, were the same land kept in bluegrass 23,200 years would pass before the same amount of soil would be lost. These results were obtained on a 12-percent slope in an area that received 34.5 inches of rainfall per year; such results show how grass holds the soil.

At Bethany, Mo., the Soil Conservation Service experiment station obtained similar results: Over a 5-year period having an average of 34.8 inches of rainfall per year, Shelby loam soil with a slope of 8 percent lost 31.2 percent of the total rain from bare ground and 9.2 percent from land that was protected by bluegrass and timothy. This run-off carried with it 112.8 tons of soil per acre from the bare ground and only 0.29 ton per acre from the soil protected by grass.

These factors have to do only with the physical maintenance of the soil. While this is essential if land is to be farmed continuously there is another function of the grass which makes it doubly valuable. Grass forms a dense vegetative cover for the soil, thus encouraging infiltration of moisture and development of bacterial life, and protecting it from some of the devastating weather conditions. At the same time grass sends out an enormous growth of very fine fibrous roots which penetrate the soil to a depth of several feet. Far greater tonnage of organic matter is supplied to the soil by grass roots than by its top growth. The undisturbed roots constitute a much more stable form of organic matter as they break down by oxidation less rapidly than organic matter or vegetation on the surface of the soil. While most of the root system for the normal pasture grasses is within the surface 6 to 10 inches, yet under many conditions grass roots extend 5 to 7 feet below the surface.

The character of growth of these roots is extremely important. They are very fine and have the ability to penetrate into many more of the soil pores than other vegetation. Because of their habit of fine root growth they are continuously sloughing off and sending out new growth further to fill the soil with organic matter in the form of tiny threads which bind the soil together. The roots of the ordinary pasture grasses, being high in carbon, resist decay and supply a stable form of organic matter. Soil filled with this type of organic matter not only will resist erosion and absorb and hold more water but will possess also that quality much discussed and little understood, called "good soil structure." The final break-down of this organic matter forms relatively large quantities of organic acids that act on the mineral constituents of the soil and facilitate those processes producing a fertile soil—an essential factor in stabilizing agriculture.

The highly specialized one-crop farm is gradually passing with the disappearance of virgin land. As long as the new soils were highly productive almost any kind of farming would provide enough products to supply the average family plus some for the market. In the Great Plains there are still some areas with sufficient fertility, preserved as a result of limited rainfall, to permit continuation of the one-crop system. In most of these areas physical soil losses due to wind or water erosion required adjustment in the one-crop practice long before the supply of virgin plant food was exhausted. Regardless of whether the specialized farmer was producing cotton, corn, or wheat, he frequently experienced periods of depression due to crop failure resulting from weather conditions, insect pests, or low prices. The production of one crop causes peak labor loads and the minimum of productive workdays. If the crop fails, practically all expense involved in the production of the crop continues.

With only part of the farm in cash crops and some of it in pasture, which for best utilization requires the keeping of livestock, many of these hazards are eliminated. Many farmers make profits and provide a portion of their living by feeding livestock in the winter when their time cannot be employed profitably in the field. By maintaining livestock, crop residues and immature crops which otherwise would be a loss can be converted into salable products.

Recently an agricultural worker, traveling through the farming region of the Great Plains, had occasion to stop for dinner at a number of farm homes. Most of these farms had been severely affected by adverse weather conditions. He observed that the type of farming being followed was reflected on the dinner table. The cash-crop farmer under adverse conditions is not now enjoying the same living standards as the man who has a diversified system with a few cows, a small flock of poultry and a variety of crops. The diversified farmer is still living fairly well and is less discouraged than the man who "put all his eggs in one basket" and "stubbed his toe" on the weather.

Pasture is very closely associated with diversified farming. Feed can be produced less expensively from pasture than in any other form. Studies on market milk by the United States Department of Agriculture, in 7 districts, disclosed that pastures furnished nearly one-third the feed for the cows at only one-seventh the total feed cost. Records show that on 478 Corn Belt farms producing beef calves the breeding herd obtained practically an entire living from pasture for 200 days, and roughage and concentrates for 165 days. The pastures, which furnished over half the feed, were credited with only one-third of the feed cost. At Beltsville, Md., experiments show that digestible nutrients in grass cost $0.48 per 100 pounds, while in corn silage and alfalfa they cost $1.22 per 100 pounds on the same or comparable lands. Kansas cost studies show that corn yielding 20 bushels per acre produced digestible nutrients at a cost of $0.643 per 100 pounds, alfalfa yielding 2.5 tons per acre cost $0.258, and tame pasture yielding 2.0 tons per acre cost $0.104. In other words, the cost of 100 pounds of digestible nutrients from tame pasture was one-sixth of that of corn. As a result of the pasture and livestock the farmer has a double opportunity of selling part of his crops for cash or of using it for livestock feed. This makes it possible to take advantage of favorable price situations and make minor adjustments in the system to provide the highest income.

One farmer living in the Shue Creek area near Huron, S. Dak., farming about 300 acres of his own land and renting one section of school land, made the statement that all the profits from his operations had been derived from the livestock which were produced on the section of leased school land. This not only had supplied his living but had made up part of the deficit incurred on his own 300 acres.

Mr. Davis, living near Poplar, about 30 miles west of Culbertson, Mont., was one of those optimistic farmers who planned to grow wheat in an area of very limited rainfall. He produced a very profitable crop in 1928 and has been trying since that time to duplicate it, but thus far he has failed. He was asked, "When did the farmers of the community enjoy the most stable income with the least worry?" His answer was, "When they had 25 or more cows, raised a limited acreage of cash crops, and had more than one thing on which to depend for their living." Then they

Livestock provides an opportunity for the farmer to process his farm crops, keeping the fertility on the farm instead of selling all raw material.

usually had a few calves or a cow with which to pay taxes and supply meat for the table, but since the unusual drought the feed supply has become exhausted and it has been necessary to dispose of their livestock. They think now that it is necessary to regain the "backlog" of security in the form of a few livestock and a more diversified system. When weather conditions are favorable and prices are high there is a great deal of satisfaction in producing the maximum of one specialized crop. Usually these high income crops are accompanied by high production costs, and if the crop fails the loss is great. While the direct returns from pasture land may not be so great as from cropland, yet the production costs are correspondingly low and the resulting net profit may be even greater than from high-cost crops. The farmer who gives attention to his pasture land can sometimes make it the most profitable of any on his farm.

At Bridgeport, Nebr., H. Nagel is tenant-operator on a 240-acre farm. Part of this farm is under irrigation, part is used for dry-land agriculture and part is pasture. Fifty acres of wet alkali land used for pasture produced only saltgrass of very low feeding value. Mr. Nagel decided to improve the pasture by seeding it to strawberry clover. He purchased one pound of seed in 1936 and planted it in beds 4 feet square scattered at wide intervals over the 50 acres. His seeding process consisted of spading up the areas, leveling them down with a rake, using a scant tea-

There are no harvesting costs in this supplemental pasture which is used to relieve the pressure on the permanent pasture during the midsummer dormant season.

spoonful of the seed on each area and covering it lightly with a rake. He then laid down two fence posts and made a lattice work of lath to protect the new planting from livestock. In 1937 he bought two additional pounds of strawberry clover seed at $8 a pound and continued establishing additional areas over the 50 acres. This seeding was done in much the same way as the first. The area was used continuously for pasture and after the plants were established the posts and lattice were removed. In 1939 he had a good stand of strawberry clover over practically the entire area. That spring he turned 90 head of yearling steers on to this pasture and left them all summer. The strawberry clover provided feed for more than 6 months. The steers were weighed, in and out of the pasture, and the total gain for the 50 acres was 27,000 pounds of beef. The only additional feed supplied was a little grain during the last 10 days before the steers were taken off the pasture in preparation for full feed in the dry lot. In addition to the 27,000 pounds of beef, 368 pounds of clover seed, in the bur, were harvested from this area after the pasture season.

While this is an unusual situation, it illustrates what can be done by giving careful thought to proper land use. At the Huntley, Mont., Dry Land Experiment Station, pasture crops are grown under irrigation and are harvested by various classes of livestock. The dairy herd has produced from $40 to $60 worth of dairy products per acre per year—an achievement difficult to attain with cash grain crops.

Pasture, as any other crop, must be adapted to its environment and to the needs of the farmer. The proportion of pasture to crops on the average farm should be determined by two factors: First, the amount of time the land should be in grass to ensure soil stability and productiveness; and, second, the amount of pasture required to provide a balance with cultivated feed crops so that livestock can be profitably maintained throughout the year.

In areas with fertile soil and sufficient rainfall, tame or introduced grasses and forage plants usually produce more abundant pastures than native vegetation. Bluegrass and wild white clover, or smooth bromegrass and alfalfa, are excellent combinations and produce high-type pastures. In areas with limited rainfall, especially where droughts are prevalent, the hardy native grasses and wild legumes are more dependable and if carefully managed usually will survive the adverse moisture conditions.

When moisture is not the limiting factor in grass production then plant food, usually phosphorous, is the element limiting the volume of growth. Given an ample supply of phosphorous, legume plants are stimulated and they in turn will provide a surplus of nitrogen for the grass.

Tame or native grass can be maintained either for permanent pasture or for rotation pasture. By rotating the pasture with the cultivated land, erosion will be reduced to a minimum and the supply of organic matter in the soil will be more easily maintained. Many of the recent farm difficulties, aggravated by erosion, floods, droughts, price-depressing surpluses, pests, etc., could be averted were enough grass provided on each farm so that plowing would rarely be done except in sod. The rotation would be row crops, small grain, hay, pasture. This type of rotation is a radical departure from common practice and may be criticized; but rarely if ever has the fertility of the soil been depleted, or the general farmer gone bankrupt, because of too much hay and grass. A survey in southern Indiana indicated that those farmers with one-half of their land in pasture and one-half in crops made more money than those with one-fourth pasture and three-fourths crops. On these farms 36 percent of the total feed for dairy herds was produced from pastures which furnished nutrients at one-fourth the cost of nutrients in harvested crops.

In areas of limited rainfall the proportion of pasture to cropland should be much larger than in humid areas. This proportion will vary from one-fourth pasture and three-fourths crops to one-fourth crops and three-fourths pasture. In areas where one-half to three-fourths of the land should be in grass the croping unit probably should be from 160 to 240 acres with 600 to 1,000 acres of pasture land. In an extensive system of farming this sized unit should provide under normal conditions a fairly comfortable living for one family.

In the large transitional area of the Great Plains where the Corn Belt and general farming merge into

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A GRAZING PROGRAM FOR SOIL CONSERVATION IN THE SOUTHEAST

BY R. Y. BAILEY [1]

FOR generations southeastern farmers have plowed and hoed grass out of row crops and sold these crops to buy meat and other supplies that could have been produced at home. But of recent years there has been a gradual change from crop farming to a more general type of agriculture whereby farm income is derived from both crops and livestock. This change is converting the present generation of grass fighters into grass growers. Farmers who are increasing their livestock are finding that it is about as difficult to keep plenty of grass in their pastures as it is to keep it out of their crops. Those who are trying to supplement both their food supply and their cash income by growing more livestock are finding that good pastures are essential to the success of this enterprise. Unless a sound grazing program can be developed, this new livestock venture is doomed to failure.

Although certain factors, such as mild winters, high annual rainfall, and a long growing season, are favorable to pasture development in the Southeast, there are serious disadvantages also. Chief among the latter are poor soils and uneven distribution of rainfall.

Most of the soils in the Southeast were not rich when first cleared. A large proportion of the land now available for pastures has been devoted to the production of clean-tilled row crops for so long that it has lost most of its topsoil by erosion. As a result of this severe erosion, much of this land is now so poor that it will not produce as much as 10 bushels of corn to the acre. These eroded soils have a low water-holding capacity and the result is that pasture plants suffer from drought. With the exception of the lowland areas along streams and in natural depressions most of the land available is too dry for good pasture.

The uneven distribution of rainfall causes widely varying amounts of feed to be available in pastures during different periods of the grazing season. In periods of high rainfall, in July and early August, a permanent pasture may furnish more feed than the animals can consume, while on the other hand by the end of August the grass may be suffering because of drought. Over a period of less than 1 month the carrying capacity of a pasture may vary by more than 50 percent. This condition makes it extremely difficult to maintain an even distribution of grass throughout the growing season where permanent pasture alone is depended upon. If pasture acreage is large enough to ensure plenty of grass during dry periods there will be an excess during favorable periods, with the result that the pasture will be undergrazed and the quality of the grass will deteriorate. If, on the other hand, the acreage of permanent pasture is reduced to that necessary to provide enough grazing during favorable periods, then pastures will be overgrazed during dry periods, the sod will be injured, and animals will not get enough feed. It is obvious that the animals cannot adjust their feed needs to seasonal conditions; they must have plenty of feed during the entire grazing period if they are to make satisfactory gains.

An effective grazing program, to ensure plenty of feed during the entire grazing season and at the same time to make the best possible use of grazing land, will require careful planning. The problem might be approached by establishing a sufficient acreage of permanent pasture to carry the livestock through favorable periods, and supplementing this during unfavorable periods with hay grown on other land. This plan would be objectionable, however, because of the labor and other expense involved in growing, harvesting, and storing hay. Another approach to the problem is the use of special crops for temporary grazing during unfavorable periods. Such crops may be divided into two general classes—annuals and perennials. Such annuals as Sudan grass, soybeans, and cowpeas furnish good grazing when they are available, but their use is not always feasible because of the labor required for planting and, in the case of soybeans, for cultivation.

Unfortunately, conditions that reduce the growth of plants in permanent pastures also are unfavorable for these annuals and as a result these crops may fail at a time when they are most needed. Annual lespedeza is probably the best of all annual crops for temporary or periodic grazing. Much of the hilly land used for pasture is not suitable for the production of the more desirable pasture grasses, but such land, where the soils are moderately heavy, will grow annual lespedeza, particularly if an application of phosphate is made. On the sandy soils of the Coastal Plains, annual lespedeza suffers from drought and is

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White clover is furnishing plenty of early spring grazing in this Mississippi pasture.

less dependable than such deep-rooted perennials as kudzu and *Lespedeza sericea*.

Of the perennials that are adapted on most of the soils in the Southeast, *Lespedeza sericea* and kudzu offer the greatest possibilities for use as temporary grazing crops. There is a general opinion that animals will not graze *Lespedeza sericea*. It has been found, however, in a number of places, that if animals are turned on *L. sericea* early in the spring when the plants are tender they will graze it quite readily. In fact, results from grazing *L. sericea* have been very encouraging.

Kudzu has been used rather extensively as a temporary grazing crop for late fall on farms on Soil Conservation Service demonstration projects and C. C. C. camp areas during the past 2 years. Both *Lespedeza sericea* and kudzu have the distinct advantage of growing well on hilly land where grasses and other pasture plants are seriously affected by drought. These plants have a further advantage in that they do not require annual plowing and planting as is necessary where annual forage crops are used for temporary grazing. This is an extremely important factor, as farmers who depend upon the annual forage crops frequently fail to get them planted at the proper time because they are busy with other crops.

A simple grazing program, to provide feed throughout the normal grazing period, should include (1) bermanent pasture on the lowland areas along streams and in natural depressions, (2) a sufficient acreage of *Lespedeza sericea* for spring grazing, (3) pure stands of annual lespedeza on suitable upland, and (4) a sufficient acreage of kudzu for grazing during the fall months when the grass and annual lespedeza are retarded by drought. On sandy soils where annual lespedeza does not grow well, it will be necessary to increase the acreage of kudzu sufficiently to provide grazing during dry periods in summer. Such an arrangement of grazing plants would ensure a supply of feed throughout the grazing period, whereas, if permanent pasture alone is depended upon there will be peaks of high production when there is an excess of feed, and periods of low production when there will be shortage. In analyzing a grazing program of this kind it may be noted that permanent pastures usually are good in early spring where white clover and hop clover are included in pasture mixtures. After these plants pass their peak of growth and mature their seed, however, there is a period of shortage of grazing because grass and annual lespedeza, which have been held back to some extent by the heavy stand of clover, have not come into full production.

Lespedeza sericea makes rapid growth immediately after killing frosts are over in the spring and will fill the gap between the winter clovers and the summer grasses. In sections where white clover does not grow well, it may be necessary to depend upon winter cover crops on cultivated land for late winter and early spring grazing. After the permanent pasture comes into full production, animals can be removed from the *Lespedeza sericea* so that it may be allowed to produce

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PROFITABLE PASTURES FOR THE OHIO VALLEY

BY R. H. MORRISH [1]

WE have failed rather generally to recognize fully the great importance of pasture land and the crop produced thereon in the management of farm land. In this respect, people in the Ohio Valley Region probably are not different from those in some other sections.

It is only within recent years that we have begun to realize the value of pasture as a crop that produces feed for livestock less expensively than this same feed can be produced with any other forage or grain crop. Along with this recognition of the economic value of good pasture, we are beginning to appreciate the effectiveness of good sod in holding soil losses to a minimum on sloping land. This growth of interest in the true value of pasture land results from facts established by a large number of practical experiments and observations made by farmers themselves.

The literal definition of pasture, often used, calls it "ground for the grazing of domestic animals." On too many farms in this region, pasture is in fact mere "ground"—bare or infested with weeds and unpalatable grasses, from which the topsoil has been lost by severe erosion.

From the viewpoint of the practical and successful livestock farmer, pasture might better be defined as "an area producing a maximum amount of highly nutritious forage at a time when it is most needed, so managed as to be able to maintain its productivity and its soil-conserving qualities." A considerable number of farmers in this region have been successful in establishing and maintaining profitable pastures; timely use of good cultural practices and sensible management constitute their formula.

The Soil Conservation Service in this region is only one of the several agencies emphasizing the importance of productive pasture in the farm plan. The first job in the promotion of a sound pasture program has been and will continue to be one of education requiring the best efforts of all agencies concerned. No amount of published information or pasture management plans written into cooperative agreements can take the place of personal contact and assistance to the farmer during the time that he is overhauling his pasture improvement and management scheme and establishing it as an integral part of his farming operations. More and more, farmers are looking on pasture as a crop worthy of treatment and management comparable to that accorded other crops grown on the farm.

As a result of a unified educational program a new concept of forage and pasture crop values is developing in the minds of farmers and agricultural workers alike, and there is a noticeable trend on some farms toward what might be termed a "grassland agriculture." These changes are being made slowly; but it is encouraging to note that the most neglected fields on many farms, now set aside for the grazing of livestock, are beginning to receive much needed attention and are responding satisfactorily. In the production of corn or tobacco, of cotton or small grain, farmers are able to evaluate yield increases in pounds, bushels, or bales, because they take an active part in the harvest operation. Pasture harvesting operations are done by the livestock which, in turn, offers tangible evidence of increase in meat, wool, or milk. But the evidence is often not so readily seen.

A number of rather serious difficulties have been encountered in the establishment of productive pasture on many farms. Designating an area of land as "pasture" on the basis of its land-use capability does not make it so. Altogether too much optimism has been present in the minds of many in thinking that an eroded tract of broomsedge and poverty grass can be turned into productive grazing land in only one or two growing seasons. These "vegetative skeletons," if not too far gone, can be brought back by following a prescription of rest, proper plant food, and careful treatment. Fortunately, comparatively few of the pastures in this region are in this completely worn-out condition.

Other difficulties encountered may be described as follows: (1) Most farms are overstocked on the basis of present carrying capacities; (2) fencing often is inadequate to provide necessary protection for the resting and renovating of old pastures; and, (3) winter grazing is an habitual practice in many areas where it is impractical and destructive. The failure and inadequacy of stock-water supplies, particularly during dry summer months, often is an added difficulty where rotational grazing should be followed.

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The farm of E. F. Humphrey, Grant County, Ky., is fenced to permit proper pasture management, including rotational grazing. Pasture field in foreground to left of fence has been grazed down to approximately 2 inches, and stock will soon be moved to pasture on right of fence where grass is now about 6 inches high. Contour tillage and contour fences are used where needed.

Any workable pasture management program must be a practical one that can and will be followed. It must be devised to fit the problems of the individual farm, at first perhaps on a limited scale, with sufficient provision for changes and improvements as progress is made. The initial plan for the establishment, improvement, and maintenance of good pasture may carry all the features of an ideal program, but it is often economically impossible to initiate all its phases without delay. The farmer may be unable to meet the entire financial obligation involved in purchasing lime, seed, and fertilizer, and in building necessary fences.

In this region, a specific plan for pasture improvement is being followed and is producing the desired results on many farms. Because of wide variations in climatic and soil conditions and in the adaptation of forage grasses and legumes, the treatment has been designed for general application and is modified, as needed, to fit individual farms. This program is based on at least six fundamental practices.

Feed your pasture and your livestock will be fed.—Adequate soil amendments in the form of lime and fertilizers must be applied, if worth-while results are to be obtained. Farmers ask, "Does it pay?" Their own observations and experiences are teaching them that if they feed pastures, livestock likewise will be fed.

Virgil Stipp of Lawrence County, Ind., together with several of his neighbors maintained records, during 1938 and 1939, of animal-unit days of grazing per acre on treated, untreated, and supplemental pastures on their farms. Mr. Stipp's records show that he received approximately 68 cow-days per acre per year from the treated pasture area, and only 29 from the untreated tract. "Pasture treatment pays on my farm" he observes, "and I am increasing the treated acreage as rapidly as I can."

Numerous farmers throughout the region are learning by doing, and they report successful results. C. M. Flege of Grant County, Ky., for example, attributes his success in livestock farming to his management practices. "If you want good pastures, rotate your grazing, use lime, mow the weeds, and keep growing legumes with the grass," he advises.

In the treatment of pasture land, blanket recommendations often are hazardous, since each area presents a different set of conditions as to requirements and past history. Nor do half measures serve to demonstrate effectively the value of such treatment.

In most instances the pasture area which will give the quickest and greatest returns for the work and money spent should be first to receive the necessary treatment. This approach enables the farmer to extend treatment to other areas of his land from which lesser returns may be expected, and also affords a better demonstration of the possibilities of pasture improvement.

Heavy grazing is an intensive type of farming, when one considers the amounts of plant food removed from the soil, and too often the mineral content of the forage which is closely related to the health and productivity of the animals is given insufficient consideration. If the calcium, phosphorus, and protein content of the herbage is low, it is possible that an animal is on a starvation diet. This fact is another good argument in favor of the economy and practicability of pasture treatment.

An empty stall pays better than a poor cow.—A tendency exists on the part of many farmers to overrate the present carrying capacities of their pasture areas. If success is to be attained in pasture improvement, it may become necessary to reduce temporarily the number of livestock during the period of establishment and renovation. E. G. Meeks, a livestock farmer in northern Kentucky, sold a flock of sheep as an important step in initiating his plan for better pastures. He later replaced them, and has increased his livestock population progressively over the original number. His satisfaction is expressed thus: "My pasture fields are now worth $5 more per acre, on the average, due to the rest from grazing."

Membership in a dairy herd improvement association has helped many farmers to reduce the number of animal units without reducing returns from livestock products. A Michigan dairyman made the following sage observation relative to benefits derived in this manner: "I have learned that an empty stall will make me more money than a poor cow."

Average pastures in the Ohio Valley Region can be so managed that they will carry more units of livestock than now exist on them, but not if they are overgrazed and mismanaged—not even with adequate treatment.

Stock in the shed saves sod in the field.—Winter grazing is a habit, and one that is inadvisable from the standpoint of production except in certain sections in the southern part of this region. After the first killing frost in the fall the food nutrients contained in most pasture forage are extremely low and, although there may be a bulk of forage in evidence, its feeding value is not comparable to good hay. In addition, winter grazing results in the destruction of the turf and promotes weed growth and soil erosion. To change this habit, it is necessary to provide legume-grass hay and, perhaps, corn or hay crop silage. This, in turn, permits barn or shed feeding and maintains production at fairly high levels.

Permanent pastures need some help.—In those parts of the region where dependence is placed on permanent bluegrass pastures, it is fundamental that other types of grazing be provided during the midsummer when permanent pastures are least productive. In all probability, the best type is a mixture of drought-resistant legumes and grasses, such as alfalfa and smooth bromegrass. Wheaton Hicks, a farmer in Livingston County, Mich., is using this combination for both hay and pasture, and reports his observations as follows: "Alfalfa-brome makes a good pasture. It furnishes feed of excellent quality during the hot summer months when bluegrass is dormant. The milk production of my herd was kept up during this period."

Sweetclover, Reed canary grass, and annual lespedezas, when properly managed, also offer possibilities for this use. If these crops, particularly alfalfa, are not well managed, a shortage of high-quality hay may result; and if grazed during critical periods in the fall, adequate recovery of root reserve may not be attained. Annual supplemental crops, such as Sudan grass and millet, may be needed, but as they require annual seedbed preparation they are expensive and erosion-inducing.

Give him stock water and his plan is complete.—Water supply is one requirement of a complete pasture program, the importance of which is often underestimated. Adequate and dependable water supplies must be provided if successful management and improvement, as well as economic livestock production, are to be secured. A farmer in southern Ohio remarked: "Now that I have a good, dependable water supply in the pond and a cement watering tank, I can really begin to accomplish something with my pasture improvement plans." During each of the three previous summers, he had found it necessary to haul water 3½ miles, which is just another way of saying that no one factor will upset the scheme so quickly or so completely as a dry year and corresponding failure of stock water supply.

The eye of the master fashions his sward.—Numerous management features, such as timely clipping, increase carrying capacities and the quality of the turf. For the most part, these practices are not burdensome and do not necessitate any considerable cash outlay.

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GRAZING MANAGEMENT FOR PERMANENT PASTURES IN CORN BELT AND NORTHEASTERN STATES

By M. A. HEIN [1]

FERTILITY is of the greatest importance in increasing pasture production, and a system of soil treatment is essential to accomplish this end. The most critical period for maintaining production is during the hot, dry summer months. Under these conditions fertilizers, particularly nitrogenous fertilizers, fail to maintain production equal to that of spring and fall periods. In this summer period, when annual crops require attention, management of permanent pastures by certain grazing practices must be followed. Even the best permanent pastures rarely produce half as much forage during July and August as they do during May and June.

To ensure sufficient pasture during the critical summer months, one of several methods of grazing management may be followed. If permanent pastures are intended to supply feed throughout the entire season, sufficient acreage should be available to provide adequate forage during seasons of minimum production. This may be accomplished by deferring the grazing on certain areas until midsummer so that the herbage will contain a large percentage of mature grass that is low in protein and high in crude fiber. Certain legumes naturally will be a part of such a mixture, and they in combination with some of the immature grass leaves will make the herbage sufficiently high in nutritive value to furnish forage that will maintain beef cattle. There is some question as to whether or not such pasturage has enough nutritive value for milk cows; it is certain, however, that such pasturage is superior in quantity to that obtained from permanent pasture that has been closely grazed in the spring and early summer with no reserve feed for the dry summer months.

If there is an excess of permanent pasture during spring months, the growth may be removed either as hay or silage for supplementary feed during the summer or winter months. It should be removed early in the season in order that the plants may attain sufficient growth before drought periods. Such management will not suppress the white clover, as the excess grass is removed while the clover is still growing and there is usually enough rainfall for its maintenance. In regions where annual lespedezas are adapted, the grass is removed while climatic conditions are favorable to the rapid establishment and growth of these legumes.

Rotation grazing of permanent pastures is excellent in theory for maximum utilization of herbage high in nutritive value. In general practice, however, it requires a larger number of animals during the early grazing season, for utilization of all herbage in its vegetative stage, than can be carried on the same area during the hot, dry months of summer. Again, in this system, excess spring growth may be removed as hay or silage if enough permanent pasture acreage is maintained to carry all animals during periods of minimum pasture production. When succulent forage is desired during summer months, usually some form of supplemental pasturage or barn feed should be provided even with a rotation system of grazing, unless moisture conditions are ideal throughout the growing season.

The ideal permanent pasture would be one that would carry the same number of animals throughout the entire growing season with forage at all times equally high in nutritive value. For the present, this goal has not been reached by any system of grazing management, fertilizer treatment, or by the use of proper combination pasture plant mixtures. Because of this it has been necessary to use supplemental or temporary pastures to maintain uniform production. Sudan grass and millet have long been used for emergency hay crops, and more recently Sudan grass has been widely used for pasture. Soybeans and sweetclover also have been used for similar purposes. Temporary crops requiring plowing and seedbed preparation add materially to labor costs and at the same time leave the soil without a cover so that it is subject to soil losses unless the land is level or so managed that such losses are controlled. The ideal supplemental pasture is one that requires the least labor for establishment, maintains continuous cover, and finally provides a maximum of forage.

In regions where Korean lespedeza is adapted it probably is the most ideal crop. It can be grown with

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fall- or spring-seeded small grains. The cereal crop, removed either as grain, hay, or pasture, when interplanted with Korean lespedeza, furnishes an ideal soil cover until ready for grazing. For maximum production of Korean lespedeza, certain grazing management practices must be observed. The most important of these practices is to graze early and as closely as possible within reason. It has been observed that if rainfall is below average the lespedeza is more productive and makes much better cover under these practices than when allowed to attain considerable growth. The close grazing does not interfere with natural reseeding.

In regions where Korean lespedeza is not adapted, sweetclover may be used in a similar manner. A few farmers have followed the practice of seeding timothy with the sweetclover, contending that the timothy will furnish a bottom grass and a better mixture for grazing. Ladino clover also is used, but it is generally seeded as a permanent pasture. Ladino requires rather exacting soil fertility conditions as well as grazing management practices for maximum production and to maintain a stand.

The practice of using the hay aftermath for supplemental pasture is one which should be more widely employed. If the hay crop is removed early, excellent pasturage will be had during the summer. A combination of bromegrass and alfalfa, used for hay, provides ideal summer pasture and soil erosion control. The stand of alfalfa will not be injured if properly managed.

A full discussion of all the elements that enter into the complicated pasture problem, such as grazing-management requirements for permanent pasture and individual crops and for different classes of livestock and soil-erosion relations, cannot be given in this paper. Data obtained from a few experiments in recent years, however, will show in part the value of different systems of grazing management in attempts to increase pasture returns, and also the importance of grassland in agriculture.

The first experimental work in grazing-management practices for permanent pastures in the eastern United States was started at Blacksburg, Va., in 1908. This work included studies of different intensities of grazing as well as of alternate versus continuous grazing. The results showed only a slight difference, in favor of alternate grazing.

The division of forage crops and diseases, Bureau of Plant Industry, in cooperation with the animal husbandry division of the Bureau of Animal Industry, conducted grazing-management experiments at Beltsville, Md., from 1929 to 1934 inclusive. Under the conditions of these experiments no significant differences in steer gains per acre were found between pastures heavily grazed continuously or alternately. The six-year average gain per steer on the continuously heavily grazed pasture, at the rate of one steer per acre, was 196 pounds per acre as compared with 194 pounds per acre on pastures alternately and heavily grazed. Steers on continuously and lightly grazed pastures, grazed at the rate of one animal to 2 acres, made an average gain of 287 pounds per steer as compared to an average of 195 pounds per steer on the heavily grazed pastures. The gain per acre, however, under light grazing, was only 145 pounds. Under the light grazing, considerable surplus forage remained at the end of the regular grazing period, and during 2 years of the experiment this surplus forage was used for late fall pasturage by thin feeder steers. The steers on this pasture made an average additional gain of 43 pounds per acre. This system of utilizing surplus forage in late fall, to bring feeder cattle to full feed, may have considerable value.

Growth of annual lespedeza in a permanent pasture, October 1933, after 5 years of continuous light grazing; Beltsville, Md.

The different rates of grazing had an important effect on the plant population. Canada bluegrass, timothy, orchard grass, and lespedeza predominated under light grazing, while Kentucky bluegrass and white clover predominated under heavy.

In another pasture experiment at Beltsville, Md., in cooperation with the Bureau of Dairy Industry, in which the Hohenheim system of pasture management was investigated, it was found that the Hohenheim system—rotation grazing with dairy cows and heifers—increased the yield of total digestible nutrients 10.4 percent over continuously grazed and fertilized pasture in similar manner. From these results it was concluded that a 10-percent increase from rotation grazing would not be sufficient to justify construction of permanent division fences and the provision of necessary shade and water in each pasture. It was also found that the heavy fertilizer treatments failed to improve carrying capacity throughout the grazing season.

At Sni-A-Bar Farm, Grain Valley, Mo., grazing management experiments have been in progress for a number of years, and here, in addition to comparing continuous and rotation grazing, a study has been made of supplementary pasture. Each unit of permanent pasture is 25 acres in size. The fields for rotation grazing are divided equally in three parts. The rotation-grazed plus supplemented pastures contain 10 additional acres upon which a wheat crop seeded with Korean lespedeza is grown. During the seasons of 1937 and 1938 very interesting results were obtained. The precipitation during the 1937 season totaled 31.6 inches or 6.4 inches below the average, while during the 1938 season rainfall was average, or approximately 37.8 inches. The live weight gains under continuous grazing in 1937 were 64.2 pounds per acre; rotation grazing, 71.8 pounds; and rotation-grazed plus supplemented grazing, 108 pounds. In 1938 gains per acre for continuous grazing were 154 pounds; rotation grazing, 169 pounds; rotation grazing plus supplemented, 166 pounds.

It was interesting to note, during the 1938 season, that the total gains on bluegrass in the rotation-grazed and supplemented pastures were 196 pounds per acre for the bluegrass and 91 pounds per acre from the lespedeza pasture. The supplemented bluegrass pasture was rotation grazed before and after grazing the lespedeza. The 10-acre field of lespedeza, in addition to giving a gain of 91 pounds of beef per acre also produced a yield of 15.4 bushels of wheat per acre. The wheat yield was severely injured by abnormally wet weather which caused leaf rust. The wheat lodged badly and no doubt this decreased the stand of lespedeza. Throughout 1938 very little difference was shown in total gain per acre between the different methods of grazing. However, when compared to 1937, a dry year, the gain per acre under supplemented grazing was materially increased. In 1937 the gains from bluegrass pasture under supplemented grazing were 110 pounds per acre and 102 pounds per acre from the lespedeza. In other words, an addition of 10 acres of lespedeza to 25 acres of bluegrass (an increase in acreage of 40 percent) increased the total live-weight gains 122 percent over the average gains of the other two pastures.

Thus it is shown that if thought and attention be given to the grazing management of pastures similar to that given to the production of the so-called cash crops, not only will the farm income be increased, but the hazards of short crops and limited feed supplies will be materially reduced. The problem, of course, has many ramifications; at the same time a system of grassland agriculture must be devised which will reduce fertility losses and loss of soil by erosion to a minimum. The ideal pasture improvement program should be designed to increase the supply and quality of forage, thereby lowering costs of livestock production, rather than to increase the number of livestock.

PROFITABLE PASTURES FOR OHIO VALLEY

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Such features as deferred and rotational grazing are dependent on fencing, supplemental pasture, and adequate supplies of good hay. Overgrazing is probably the most outstanding example of mismanagement but can be avoided in most seasons if the other phases of improvement and maintenance are being considered.

A most practical expression of the farmer's response to the program was voiced by a western Kentucky dairyman when he said "I know that I have been guilty of overgrazing and careless treatment but now after 3 years of work I am getting my pastures in good shape. I have learned that lime and phosphate, when applied to the pasture, do not give good results unless I manage them right and mow them often." Whether the pasture is Bermuda grass, bluegrass-white clover, or alfalfa-grass, the time element is an all-important factor in management.

In the final analysis, sensible management is the keystone to successful pasture improvement, but, before approved management practices can be applied on many farms, it is necessary first to establish a vegetative cover worthy of being called pasture.

BETTER PASTURES FOR ILLINOIS

BY E. D. WALKER [1]

A PASTURE can be no better than the soil—such is the message that is being carried to Illinois farmers by the Extension Service as part of the pasture-improvement program in that State. The message is bearing fruit in the form of increased acreage of really good mixed grass-and-legume pasture.

The problem of what to do with land retired from crop production under the adjustment program, the need for grasses and legumes in erosion control, and the failure of old permanent pastures to revive following the drought years of 1934 and 1936 have all served to focus attention on pasture production. For some years Illinois farmers in general have recognized the need for soil treatment to assure them of good yields on much of their cropland. They may not have acted on this knowledge but at least they have recognized the need. But in the matter of pastures no such general acceptance of the necessity of soil treatment prevailed; in fact, the more common notion is that pasturing alone improves the soil. Rolling permanent pastures are expected to go on producing abundantly without treatment of any kind, and cropland worn down to the point of unprofitable returns is merely seeded to grass and called pasture. Much of this pasture land in its present state of fertility produces little and is, in effect, merely an exercise lot for the livestock. It has been the task of extension workers to guide the recent interest in pastures in the right channel and to drive home need for an ample amount of fertility if good forage is to be produced.

Pasture improvement extension in Illinois is no new activity. Rather it should be said that it is receiving new emphasis. Fifteen to twenty years ago farmers were being advised to apply limestone to permanent pastures in order that clovers, particularly sweetclover, might be introduced to produce additional forage and also to improve the growth and quality of the grass by supplying nitrogen to it. Here and there over the State men followed the suggestion, and the pastures they thus established are still among our best available demonstrations.

For example, over 16 years ago the extension agricultural engineer assisted Henry Means of Brown County in terracing a small acreage of worn, gullied cropland which was later limed and seeded to a mixture of bluegrass and sweetclover, and as Mr. Means expresses it, "I shut the gate and I haven't been back except to turn the livestock in or out." The mixture of sweetclover and bluegrass has been maintained throughout the years and with judicious grazing a wonderful sod has developed which precludes any possibility of erosion and which supplies an abundance of good forage. One has only to look over the fence at a neighbor's gullied and well-nigh abandoned field to realize what an excellent job of land use Mr. Means has done. Similar results have been obtained by other men who have followed the same general methods.

Recognizing the increased emphasis being placed on soil conservation by the different departments of the College of Agriculture and by other agencies, a move was made by the Extension Service in 1936 to bring together all the forces working in this direction. The result was a coordinated project in soil improvement and erosion control in which the extension specialists from all the interested departments participated, including agricultural engineering, agricultural economics, crops, forestry, animal husbandry, dairy husbandry, and soils. The Soil Conservation Service has also lent its assistance. By having the specialists cooperate in a project of this type it has been possible to bring to farmers of the State a complete picture of what is needed in a good program of soil improvement and erosion control. This has been a decided improvement over the old method under which each specialist presented separately his angle of the subject, without relating it closely to other phases which should be considered.

The project has been built around the training of a group of leading farmers in each of the cooperating counties. The object has been to train these key men to recognize the problems of soil conservation, to give them information regarding the best methods of improving fertility and preventing erosion, and to inspire them to put these methods into practice on their own farms. The idea has been that after a time these farms can serve as demonstrations on which good conservation practices can be seen in actual operation and, furthermore, that the operators themselves will be sufficiently well informed to pass the information and technique on to their neighbors.

Winter meetings have been held with these leaders during the past three years in an increasingly large

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number of counties until now almost the entire State is covered. At these meetings the specialists have discussed soil conservation from all angles and have emphasized the place of soil fertility, crops, forestry, engineering practices, and farm planning in the program. Animal husbandry and dairy husbandry also have been brought in from the standpoint of utilizing the crops grown.

Pastures and pasture improvement have entered largely into these discussions. On cropland there is the problem of using the additional acreages of legumes and grasses needed for improvement of fertility and for erosion control. Rotation pasturing presents one good outlet for this forage and has been considered in the building of rotations and in developing farm plans for soil conservation. Soil treatment practices which will ensure regular stands of soil-building legumes are, of course, stressed in this connection.

On the acreage that is to be left in permanent pasture, much of which is rolling land, farmers have been urged to follow practices designed to ensure the heavy growth of vegetation needed to provide a high yield of pasture forage and to control erosion. Combining the experience of practical farmers with experimental data, a suggested program of pasture improvement has been worked out which includes five definite and simple steps:[2]

1. Test and treat the soil: Limestone is needed in varying amounts on most pasture land, and a considerable acreage is deficient in phosphorus.

2. Disk well: This is needed to work lime or phosphate into the soil and make seedbed for new seedings.

3. Reseed: Various mixtures of legumes may be used but sweetclover is regarded as a stand-by on all types of land. Where few or none of the desirable grasses are present, they should be included.

4. Control grazing: Grazing should be limited sufficiently to maintain a good top growth on the field through the year.

5. Clip weeds: Improving the soil to encourage increased growth of good pasture plants helps with the weed problem, but some clipping is a further aid.

The pasture program has been well received by the leaders who have indicated that there is a wide interest in the subject. Out of more than 3,000 attending the 1939 winter schools, 645 farmers stated that they had carried out pasture improvement work in 1938, and 948 indicated an intention of doing such work the ensuing season. Excellent demonstrations are being developed in this manner. The Tennessee Valley Authority is also cooperating with the College of Agriculture and Extension Service in demonstrational work in the use of phosphates on pastures and legumes. This work is being carried on as part of the coordinated project, and in each of 11 counties in the State from 10 to 20 farmers are developing some excellent demonstrations of the value of lime, phosphate, disking, and legume seedings in increasing the carrying capacity of pastures.

Regardless of how good a demonstration may be developed, it is of value from an educational standpoint only as other farmers visit it, observe the results secured, and learn of the methods used. In view of this fact, tours and field meetings have been a regular and definite part of the activities carried out in connection with the coordinated soil conservation project. Farms used for such meetings have been those on which some good soil-improvement and erosion-control practice has been adopted or on which some good lesson in soil conservation can be pointed out. With respect to pastures, the tours have included some farms where a good improvement program is well under way, some where it has just been started and, for contrast, others where nothing has been done.

Definite evidence is available to show that these tours and field meetings have been effective in convincing farmers of the possibility of improving pastures. For example, William A. Miller, of Schuyler County, attended the pasture tour held by the farm adviser and extension specialist in that county in the summer of 1938, and he was so impressed by what he saw and heard that he immediately started the program of liming, disking, and reseeding on his own permanent pasture field. The resulting stand and growth of pasture grasses and legumes were so good that the field was used for one stop for demonstration on the 1939 tour. Another Brown County man, after visiting the Henry Means pasture mentioned earlier in this article, went home and started the liming of 10 acres of pasture land on his farm. These are only two examples among many that could be cited.

Farmers have been urged to use increased pasture acreage and pasture improvement to control erosion and to take up the slack due to retirement of acreages from crop production under the adjustment program. While it is true that both objectives can be reached by the production of more and better pastures, farmers are reluctant to follow this course because of the idea that pasture land does not hold the same possibility of returns as does cropland. With this in view the effort has been made in all meetings and tours to present information and data indicating income that may reasonably be expected from well-utilized pasture.

Data from the experimental farm at Urbana show an interesting comparison in this connection. Pastures

[2] J. C. Hackleman and E. D. Walker: Five Steps in Pasture Improvement. mm. leaflet, 12 pages, Department of Agronomy, University of Illinois.

used by the animal husbandry department and which have been well limed, phosphated and manured, show a 4-year average production (1934, 1935, 1936, 1938) of 272 pounds of beef per acre. In this test various kinds of pasture have been used including alfalfa, bromegrass, alfalfa-brome mixture, bluegrass, timothy, orchard grass, sweetclover, oats, and other combinations; and this figure represents the average of all these plots during the 4 years. In contrast, beef production calculated on the basis of crop yields secured from rotation land of similar quality and treatment on the south agronomy farm during 4 years, 1935–1938, is somewhat higher than that of the pasture land. When expense of operation is deducted in each case, however, the net return is somewhat in favor of the pasture system. It seems safe to say that good pasture, well utilized, will make a return comparable with that from cropland of equal quality. Results from other experiment stations indicate similar returns.

Farmers over the State who are using pastures to good advantage make similar reports. E. O. Whittaker, one of the T. V. A. cooperators in Bond County, has 70 acres of pasture land which he bought in 1937. He had been renting this land at $1 per acre cash rent, but had decided not to continue this arrangement because it was not profitable. The owner then sold him the land for $12 an acre. The field was limed in the fall of 1937 and sown to rye with a seeding of timothy and redtop. The following spring sweetclover and lespedeza were sown in addition. The entire investment per acre, including cost of land and expense of treatment, was as follows:

Cost of land	$12.00
Lime (4 tons)	10.60
Seeding	2.00
Fencing	5.40
Total	30.00

A herd of dairy cows was run on the field for 2 months in 1938 and for 7 months in 1939. During these 9 months the returns which can properly be credited to the pasture, after making deduction for any other feed fed, totaled $2,610 or $37.29 per acre on a $30 investment. No such return could reasonably have been expected from this land if Mr. Whittaker had depended only on production and sale of crops.

Oscar Linn, a Fulton County farmer, reports that in 1938 a 20-acre permanent pasture field was the most profitable acreage on the farm, its value in feed saved in beef production as compared with dry-lot feeding being over $26 an acre.

Results such as these serve to strengthen the conviction of extension workers in Illinois that they are using sound judgment in recommending that good pastures will control erosion, will make good use of land retired from crop production, and at the same time will offer an opportunity for profitable return. But the fertility needs of the soil must be taken care of, and around these needs the program in Illinois is being built. The plan appeals to farmers, and they are responding because they are beginning to realize that "a pasture can be no better than the soil."

GRAZING PROGRAM IN SOUTHEAST

(*Continued from p. 244*)

a crop of hay for winter feed. The permanent pasture should supply plenty of feed from near the 1st of June until about the 1st of September. By July, the annual lespedeza or the kudzu planted on the hilly land will furnish excellent grazing and can be utilized during any short periods of drought during the summer. Kudzu can be grazed at any time during the fall that is made necessary by the condition of the permanent pasture and the annual lespedeza. A system of this kind will not give year-round grazing, but it would provide a fairly stable supply of feed from early spring, when clovers in the permanent pasture or when winter cover crops in cultivated fields are available, until after frosts in the fall.

It is important that the most suitable land be selected for permanent pastures and that this land be treated with sufficient lime and phosphate to ensure vigorous growth of desirable pasture plants.

The inclusion of other grazing crops in the program will not lessen the need for good management practices such as fertilizing, weed control, and controlled grazing for permanent pastures. The availability of other grazing crops, however, will make proper grazing of permanent pastures feasible. Farmers cannot be expected to remove animals from permanent pastures during periods of drought unless they have some other place available that will provide feed for them.

A further advantage of a grazing program including different types of grazing crops is the reduction in permanent pasture acreage that will be possible. This reduced acreage enables the farmer to give more intensive management and maintenance treatment, including fertilizing, liming and weed control, than is possible on an extensive acreage of pasture.

There are possibilities for winter grazing through the use of small grain, Italian ryegrass, and the winter legumes. The early winter growth of such crops

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FACTORS IN PASTURE MANAGEMENT IN THE NORTHEAST

BY GROVER F. BROWN[1]

IN the Northeast there are approximately 25,000,000 acres of pasture, with about one-third of it classed as woodland pasture. In this vast acreage some 6,030,000 head of cattle, 1,095,000 horses and mules, and 1,486,000 sheep are grazed. Good pastures produce the most economical feed for these classes of livestock, and for this reason pasture management is of utmost importance to farmers of the region.

The length of the grazing season varies from 5 to 7 months. Many farmers allow their livestock to roam the pastures during most of the year—a practice that is extremely injurious to the better pasture plants. Winter feeding of corn fodder and hay, on the pastures, is common in some sections also, and this in itself is likely to be a source of damage to the vegetation. Such winter feeding seriously damages soil structure through trampling so that moisture penetration is hindered and rapid run-off of practically all rain and melting snow occurs. It may result also in complete denudation of the above-ground vegetative parts which if protected are valuable as winter cover.

From the point of view of pasture management there are at least three periods in the grazing season when care must be exercised to prevent undue damage to desirable pasture plants. One of the major causes of decreasing vigor of pasture plants is too early grazing in the spring before the ground is sufficiently dry to prevent damage by trampling and before the vegetative parts of the plants have had an opportunity to replenish food reserves in the roots. Some plants, such as wild white clover, suffer from shading when the grass in the pasture mixture grows too tall. However, when the faster-growing grasses are grazed too closely in the early spring and are not given an opportunity to recover while growing conditions are favorable, their production suffers later in the summer when conditions are often unfavorable.

Supplemental pastures usually are necessary for the average Northeastern farmer during the hottest part of the summer. At this season of the year severe overgrazing of the better pasture plants may damage them so severely that they cannot compete with the annual weeds that spring up in the early fall. Proper rotational grazing sometimes helps in carrying the livestock over this season. In dry years, however, even the best permanent pastures cannot carry the same load in midsummer that is advisable in the spring and early summer for the utilization of the herbage then available.

With the coming of cooler weather in late summer and early fall and its accompanying lower evaporation and transpiration, the permanent pasture grasses and legumes have opportunity to regain their vigor rapidly and prepare themselves for winter. If they are too closely grazed before and during this season, they must of necessity go into the winter in an undernourished condition, and this leads to severe winter injury. Late fall and winter pasturing can thus be an extremely harmful practice for farmers with grazing livestock.

For many years the agricultural experiment stations have pointed out the value of proper liming and fertilizer treatments of pastures. Likewise, the value of mowing to control weeds and prevent pasture herbage from maturing has been proved many times. It is apparent, however, in many areas, that these proved and tested practices require further stressing to maintain progress in an advantageous grazing management and pasture program. In recent years a great deal of attention has been given to the production of superior types of pasture plants, and this in itself undoubtedly will be of immense value to pastures of the Northeastern Region.

Proper liming, fertilizing, seeding, mowing, and grazing management all are extremely important, but unless there is sufficient moisture in the soil there can be no plant growth. For this reason, moisture may well be listed as one of the fundamental pasture requirements. In the irrigated sections of the West this factor has been given primary attention, but in the hûmid sections of the East farmers have depended so completely upon rains coming at the right time that very little effort has been expended in the supplementing of natural rainfall. Practically the entire system of "dry-land" farming and "summer fallowing" west of the Mississippi is based on the storing of water in the soil before it is required for plant growth so that it will be available when needed. Since this practice is desirable and feasible, does it not follow that surplus moisture in seasons of plenty should be stored in the

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soil for use by pasture plants during the periods of scarcity in summer wherever it can be done economically?

Contour pasture furrowing is one of the practices which the Soil Conservation Service has sponsored to help this condition of moisture shortage during summer months. If the grazing season can be extended at this season of the year by only a few days, it will in many cases justify the small costs involved. Many of our summer rains come in the form of heavy thunder showers of high velocity and short durations. As a result of the more or less dormant condition of the vegetation and the dry hard condition of the surface soil, much of the water from these rains is lost to the pasture by run-off. This fact is particularly important on steeper portions of the pasture where the surface soil is thinner and the stand of vegetation sparser. It has been shown by soil conservation experiment stations that on good pasture sod, with limited slope and length of watershed, practically no run-off occurs. Yet under general pasture conditions, especially on overgrazed and poorly managed pastures, there undoubtedly is run-off, which means water wastage, lost fertility, and soil erosion.

As properly constructed in the Northeastern Region, contour pasture furrows have a holding capacity of approximately one acre-inch, equivalent to about 113 tons of water per acre. Many of our summer thunder showers are of this quantity or in excess. Increased absorption by reason of the furrows, plus normal soil absorption, should do much toward extending the summer grazing season.

Preventing surface run-off from at least the steeper, poorer spots in the pasture aids in preventing run-off from the pasture as a whole. This in itself is important to the farmer and others as well in that it reduces possible flood hazards on the lower reaches of the watershed, reduces siltation of reservoirs, erosion of bottomlands below the pastures, and other damages attributed to excess run-off.

When rainfall during the growing season is below the amount of moisture lost by evaporation plus that lost by transpiration, either artificial application of water is necessary or the plants must obtain additional water from the subsoil to enable them to continue to produce satisfactory pasturage. Practices which aid in maintaining optimum subsoil reserves should be stressed by any agency interested in the farmer's pasture problem.

Upon close examination of furrowed pastures in the Northeast, it has been noticed that more clover and desirable grasses grew in the furrow than between

Rear view of contour furrowing machine, showing construction and pattern of roller.

furrows. This fact may be attributed to more moisture, lower temperature, less evaporation and transpiration in summer, and also to the lodging of small seeds that are carried down the slope by any movement of water between furrows. Run-off water carries soluble fertility, and this may account for increased growth of vegetation on furrowed pastures.

As the cost of furrowing a pasture is largely one of labor, furrowing may be done during the fall or early winter when surplus labor is available. If a pasture is planned for treatment with lime, fertilizer, and seed, furrowing should be done in advance so that revegetation of the disturbed areas can be accomplished more rapidly. On pastures of low-carrying capacity because of insufficient desirable plant population, furrows may be constructed with the ordinary farm plows. Such furrows seem best when placed about 10 feet apart on the ground surface, with each furrow made by one or two rounds of the plow. Because of the fact that the lateral movement of water through the soil is very limited, the furrows must be fairly close together for maximum benefit to the vegetation.

The machine shown in the accompanying photograph has been patterned after one in Region 5 and is used for furrowing pastures already having a fairly good covering of vegetation. This machine does not turn over the existing sod as does a plow or terracer blade, and for this reason the immediate reduction in carrying capacity is greatly lessened. It also means less exposed ground surface to revegetate.

Approximately 6,000 acres of permanent pastures have been furrowed in the Northeastern Region during the past few years, and many additional acres are being planned. Those farmers who have suffered the experience of summer drought on their pastures, with its consequent costly barn feeding, are quick to appreciate the value of conserving rainfall and putting it to maximum beneficial use.

RUN-OFF UNDER DIFFERENT SYSTEMS OF GRASSLAND MANAGEMENT

BY H. C. KNOBLAUCH AND J. L. HAYNES [1]

IT is generally recognized that land used for grass production under most systems of management does not present as serious an erosion problem as does land devoted to cultivated crops. Difference in run-off, however, from various types of grass under different systems of management are less widely appreciated. Good pasture sod actually may give more run-off than clean-tilled crops under certain types of management. Management of grassland as pasture usually results in greater surface run-off than equally good stands of grass managed as hay. During winter months grassland frequently has more run-off than cultivated land, because of differences in frost content in the soil.

Inasmuch as moisture demands for optimum growth are much higher under grassland than under most cultivated crops and as the moisture requirements for grass are sustained throughout the growing season, it is important from the standpoint of yield that proper consideration be given to the relative effectiveness of methods of grassland management in prevention of run-off.

To determine soil and water losses under various agricultural practices related to dairy farming in the Northeast, the Beemerville Soil Conservation Experiment Station was established near Sussex, N. J. Considering the predominant type of agriculture of the area, investigations at the station were directed toward problems connected with grassland farming. Experiments were undertaken to determine soil and water losses from pasture land when rotational grazed and when under continuous grazing, from areas planted to grass-legume mixtures cut for ensilage, and from corn plots harvested for ensilage. Supplementary to the run-off studies, data on crop yields were obtained from the different systems of pasture management and from the various seeding mixtures used both for pasture and ensilage purposes. Some of these studies have been under way since 1937 and preliminary results are reported in this article.

The area represented by the station normally supports a very good pasture cover. The composition of pastures generally accepted as desirable for the area and that frequently obtained in properly managed pastures consists of 35 percent Kentucky bluegrass, 35 percent wild white clover, and the remaining 30 percent of various grasses and legumes, principally timothy and redtop. The mixture seeded on the plots used in the pasture management study consisted of Kentucky bluegrass, timothy, wild white clover, red clover, and alsike clover.

The soil at the station is Dutchess loam. It has developed from the underlying shale and from glacial material. In the cultivated condition, it has a brown to grayish-brown friable surface soil 0 to 8 inches in depth. The B horizon is light brown in color and somewhat more compact than the surface soil. The degree of compaction tends to increase in the subsoil. Evidence of imperfect drainage is frequently observed at depths of 24 to 30 inches. The soil is relatively high in fertility; however, most areas show marked response to fertilizer treatment. Because of the necessity for a uniform soil, slope, and erosion condition, the particular area selected for pasture management studies was in a high state of fertility due to previous treatment.

Pasture management studies are conducted on six 0.7-acre fields. Three of these are rotationally grazed and fertilized, while three are continuously grazed without fertilizer treatment. For run-off studies, each of the 0.7-acre grazing areas has located in it a 14- by 70-foot plot equipped with run-off measuring equipment. The management of the run-off plot area is the same as on the surrounding field area. With this arrangement, it is possible to get records of pasture days and animal gains as well as soil and water losses.

Vegetation on the rotational plots of this study is allowed to reach a height of 4 to 6 inches before grazing. A sufficient load is then turned on to graze the plots to approximately 1 inch within 10 to 14 days, at which time cattle are removed until recovery to 4 inches is made. Cattle are turned on the continuously grazed plots early in the spring and removed late in the fall. The grass on the continuously grazed plots usually is kept at a height of 1 to 1½ inches except during periods of insufficient moisture when the sod may be grazed to one-half inch. Both the rotational and continuously grazed plots are mowed at least twice during the season to prevent spotty grazing.

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Under continuous grazing, the sod mat forms close to the ground, white clover assuming a prostrate growth habit and filling the interstitial spaces left by the grasses. Normally a nearly complete ground cover is maintained even under severe grazing, as the plants spread so close to the ground that cattle do not strip the soil of its cover. Under the rotational system as used in this study, the closed canopy forms higher from the ground, the clover becoming more erect in competing with the growing grasses for sunlight. Thus, upon completion of a grazing period on the rotational plots, as much as 40 percent of the soil surface may be exposed with no vegetative cover while the continuously grazed plots ordinarily will have 90- to 100-percent ground cover through the season.

Comparing run-off from rotational and continuous grazing, as these practices are being carried out at this station, it will be noted in the table that run-off under continuous grazing was higher than from the plots under rotational grazing. This trend persisted throughout all seasons. Records from individual storms occurring at the close of grazing periods on the rotational plots, when percentage of ground cover was in favor of the continuously grazed plots, consistently showed more run-off from the continuously grazed pastures. It is thus apparent that vegetative cover is not the sole factor influencing run-off from pasture land. Observations and evidence from associated studies indicate that the influence of continued trampling on soil structure by cattle is one of the factors contributing to difference in run-off. It should be kept in mind, however, that the continuously grazed plots were grazed closer than the rotational plots.

The use of grasses and legumes for ensilage is rapidly becoming an important part of farm management in this as well as in some other areas where the major portion of the farm income is derived from dairying. Measurements of soil and water losses are made at the station from plots planted to a grass-legume mixture of alfalfa, timothy, alsike, and red clover, being managed for silage. These plots are normally harvested twice annually, when the alfalfa starts to blossom.

As a means for comparison of soil and water losses and of crop yield, corn silage plots drilled with the slope were installed adjacent to the grass-legume silage plots. All the silage plots are on a 16-percent slope and are on a soil closely comparable with that of the pasture management plots described above.

Referring to the table it is observed that management of grassland for silage or for hay prevents run-off more effectively than does utilization for pasture, and

Table showing run-off from grassland under different systems of management as compared with that from corn planted with the slope

Season	Rainfall	Run-off from corn (silage)	Run-off from grass-legume (silage)	Run-off from bluegrass-clover sod, continuous grazing	Run-off from bluegrass-clover sod, rotational grazing
	Inches	*Percent*	*Percent*	*Percent*	*Percent*
June, July, Aug.	14.59	8.2	3.4	8.8	5.7
Sept., Oct., Nov.	11.64	7.3	2.2	8.2	4.8
Dec., Jan., Feb.	11.54	40.6	9.1	44.2	25.4
Mar., Apr., May	11.31	1.0	0.2	1.0	0.3
Total, 12 months	49.08	14.0	3.7	15.2	8.9
Annual soil loss (tons per acre)		10.88	0.05	0.22	0.17

that this trend is sustained throughout the season. The grass-legume silage plots are not subjected to compaction by animals as are the pasture plots, and the soil is thus more porous.

In comparing run-off from grassland with open tillage, as represented by corn in the table, it will be noted that during the period of study from which these records were collected, water loss from continuously grazed pasture land somewhat exceeded that of corn throughout the year. Inspection of individual storm records, however, shows that run-off starts from corn or corn-fallow plots before it does from grassland. This may be due in part to resistance caused by physical obstruction to overland flow by the vegetation. But with sustained rainfall, causing run-off, the initial effect of run-off detention by grass cover frequently is overshadowed by the effect of higher permeability of corn ground in this experiment, causing the gross totals to reflect a slightly higher run-off under continuously grazed pasture. Under rotational grazing, permeability of the soil apparently has not been reduced to an extent to cause run-off equal to that from soil being used to grow corn for silage. Since the structure of soil under grass-legume silage plots is undisturbed and more porous, the high permeability, the high initial retention by canopy interception, and resistance to overland flow by vegetation are reflected in a very low percentage of run-off.

As indicated earlier, different mixtures were placed under study to obtain information on their relative values for soil conservation purposes and for the production of ensilage and as pasture. Ladino clover was included in one of the mixtures. The Ladino clover mixture included red clover, alsike, timothy, and alfalfa. Seeding was in the spring of 1937 and one cutting was made during the first year. In 1937 the plant population was very similar to the percentages of the mixture planted. Grazing and harvesting for

silage were started in 1938. Under grazing and silage management, Ladino suppressed all other species of the mixture to a small proportion of the total composition by the end of the 1938 grazing season. The area harvested as silage yielded 28.6 tons green and 3.98 tons dry weight per acre for three cuttings in 1938. The high yield and success of Ladino in crowding out all other species probably was due, in large part, to the very wet season in 1938. Ladino plots under rotational-grazing management gave 408 grazing days per acre for a 1,000-pound animal during 1938. During the very dry year of 1939, Ladino harvested for silage was about equal to the standard grass-legume mixture

From the conservation standpoint, the rapidity of growth recovery of Ladino is effective in providing a complete ground cover, and the stoloniferous character of the plant provides a good surface mat of roots when managed as silage. Under pasture conditions, however, the stolons appear to be easily uprooted by animals, especially under close grazing, and the animals are able to take almost all the leaves from the plants, so that only very little cover is left on the soil, such as is maintained by white clover.

Summer rainfall, during the period covered by this report, showed extreme variability. The 36-year average precipitation for the Sussex area for the season, May to September inclusive, is 20.25 inches. During 1938, 36.69 inches were recorded during the above period, while in 1939 only 12.09 inches were received.

During the wet season of 1938, rotational grazing showed slightly higher yield than continuously grazed pasture. However, due to the custom of waiting for a growth of 4 to 6 inches before grazing on rotational pastures, this practice was less productive than was continuous grazing during the drought year of 1939 when growth recovery was slow and when very little run-off occurred during the grazing season; in this year of drought there was little difference in amount of moisture conserved in the two practices.

Under conditions represented by the Beemerville station, soil losses under any reasonably good system of grassland management are small, except from new seedings. Differences are apparent, however, between various systems of grassland management, as shown in the table. The comparatively recent movement in agricultural practices, from corn silage toward grass-legume silage, is to be welcomed by the conservationist as a big step in the solution of one of the major soil conservation problems in dairy farming.

PASTURE IN RELATION TO CROPLAND

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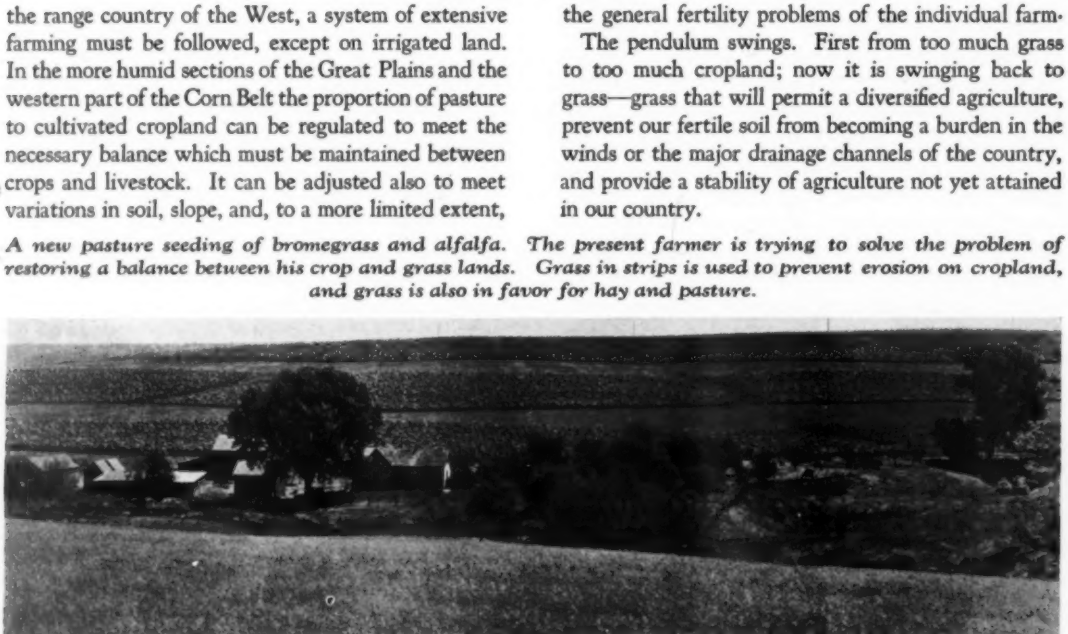
the range country of the West, a system of extensive farming must be followed, except on irrigated land. In the more humid sections of the Great Plains and the western part of the Corn Belt the proportion of pasture to cultivated cropland can be regulated to meet the necessary balance which must be maintained between crops and livestock. It can be adjusted also to meet variations in soil, slope, and, to a more limited extent, the general fertility problems of the individual farm.

The pendulum swings. First from too much grass to too much cropland; now it is swinging back to grass—grass that will permit a diversified agriculture, prevent our fertile soil from becoming a burden in the winds or the major drainage channels of the country, and provide a stability of agriculture not yet attained in our country.

A new pasture seeding of bromegrass and alfalfa. The present farmer is trying to solve the problem of restoring a balance between his crop and grass lands. Grass in strips is used to prevent erosion on cropland, and grass is also in favor for hay and pasture.



Beef cows and calves on an alfalfa-grass pasture in central Illinois. Such livestock makes the maximum use of hay, pasturage, and other roughage. While adequate crop rotations are fundamental to the maintenance of crop yields, shifting acreage from corn and other tilled crops to hay and pasturage does not increase the production of meat, milk, and other livestock products.

MORE AND BETTER FORAGE PAYS

TO MEET the land-use capabilities on most farms where erosion is a serious factor requires a considerable decrease in the acreage of the common cash crops and an increase in the acreage of hay and pasture. To bring such changes about and make them relatively permanent, the decrease in income from cash crops must be offset by an increased income from the hay and pasture. This generally involves greater emphasis on getting profitable returns from the livestock that are being kept or should be kept on the farm to balance the cash crops, and depends to a very large extent upon the fact that feed from pasture is much cheaper than feed from harvested crops.

In an economic study of dairy farming, Marvin Guin of the Mississippi Agricultural Experiment Station, points out the importance of properly cured hay and other roughage in making dairy cows pay. He says that from 75 to 85 percent of the roughage in Oktibbeha and Lowndes Counties is poor in quality because mowing is delayed until the hay is overripe. This condition, together with overexposure in curing, causes the hay to lose most of its leaves—by far the most nutritious and palatable part.

Helpful information on the making of hay of better quality and higher feeding value is contained in a number of United States Department of Agriculture bulletins and circulars such as the following:

Farmers' Bulletin No. 1525: Effective Haying Equipment and Practices for Northern Great Plains and Inter-Mountain Regions.

Farmers' Bulletin No. 1539: High-Grade Alfalfa Hay: Methods of Producing, Baling, and Loading for Market.

Farmers' Bulletin No. 1597: The Production of Johnson Grass for Hay and Pasturage.

Farmers' Bulletin No. 1770: High-Grade Timothy and Clover Hay: Methods of Producing, Baling, and Loading for Market.

Circular No. 534: Lespedeza Sericea and Other Perennial Lespedezas for Forage and Soil Conservation.

Circular No. 536: The Annual Lespedezas as Forage and Soil-Conserving Crops. —A. T. S.

GRAZING PROGRAM IN SOUTHEAST

(*Continued from p. 253*)

usually is limited because of periods of drought which frequently extend from late August to the latter part of November. Naturally, when such unfavorable seasons occur, it is impossible to get winter crops started in time to provide grazing before late winter. It is necessary, therefore, for farmers to harvest a sufficient amount of hay and other feed to carry their cattle through the winter. The winter feed can be supplemented to some extent by grazing in the fields during the early part of the winter. This is particularly true where there is a considerable acreage of kudzu on the farm. The frosted leaves of kudzu are grazed by livestock until midwinter.

Last but not least in a grazing program is the proper adjustment of livestock population to the size of the farm. In too many instances the number of livestock kept on the farm is determined by the desire of the farmer for livestock income, rather than by the capacity of his farm for supporting livestock. Overstocking will make it impossible for any grazing program to be operated successfully.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

THE AGRARIAN REVIVAL. By Russell Lord. American Association for Adult Education. New York, 1939.

Again Russell Lord has produced a book about an important phase of recent agricultural development in this country. Specifically, it is an intimate account, packed with stories of the people, of farm and farm home extension teaching from its origin to the present. It is indeed a most democratic book in more ways than one; it shows how initiative from the people starts an important idea going, how great institutions grow, slowly and with much healthy "rowing" as they are worked out by the people for the good of the people, and how at the proper time Government serves its useful purpose. Enriched by historical notes and intimate episode and vivid characterization, it is not just a book to remember as "something I read once"; it is a book that will help us all to understand a lot of things about patience in the working out of democractic institutions.

The approach is by way of rapid sketch of individual and local effort: Indian demonstration unheeded if interfering with exploitation; then unplanned or badly planned agricultural expansion with rectangular farms and 7-mile furrows; then the land-grant colleges, brought into being in time of civil war; and then many a tale of the patriarchs of agricultural education blazing the way for extension teaching, wanted by the people on the land, "at the grass roots." Davenport, Bailey of Cornell, Knapp and Spillman, Roberts, Perry Holden the "Corn Man," A. J. Whimple the farmer, "Uncle Henry" Wallace and "Tama Jim," Wilson—these are men who had much to do with the trail blazing, and they are given considerable space as agricultural teachers or workers who "weather well" or whose works are even today definitely responsible for the dissemination of knowledge by the extension method.

The story of the county-agent system of extension teaching, as it has developed from State and farmer organizations throughout the past four decades, has somewhat the tone of early pioneer history. There is the same healthy and vigorous "free talk," the same regional differences, and men and women working from dawn to far into the dark to carry adult education to the farm and the farm home. Mr. Lord worked in Ohio as an extension newsman, and he has happily chosen that State as "as representative a State as any, and perhaps the most widely representative, in a median sense" in a study of the growth of ideas and methods in extension during the post-war era. Aside from the fact that Ohio is a representative State as regards extension teaching, here is the interesting and inspiring sketch of John D. Hervey, county agent in the hills of southwestern Ohio, as well as a fine and illuminating character study of the agricultural population of Ohio.

The latter half of the book carries extension education through the vicissitudes of depressed economic conditions when farmers and farm educators raised standards and wrestled with change and turmoil. In this period home economics especially forged ahead, while Triple-A adjustment was piled high upon the shoulders of extension men in the field. In his study of agricultural adjustment payments, Russell Lord gives us an excellent account, from the ground, of the Triple-A. It is the comments from far afield that are revealing and help us to understand so many things about balance of farm production. Here, too, are more character sketches and episodes to enrich the story. We are very near "home," to present-day trends, in the last few chapters of the volume where our own Secretary of Agriculture, and M. L. Wilson, both well known to us, are sketched most revealingly as to work, ideals and character. [Most significant, by the way, is the latter's recent appointment as Director of the Extension Service of the Department of Agriculture. He was Montana's first county agent.] And here Mr. Lord, who states facts boldly, points out that one important result of depression and emergency tactics is the acceleration of soil conservation and land use for a balanced agriculture. He tells us, furthermore, that the "real story is not in Washington . . . [but] is developing in terms of an increasing participation by farm men and women in changed ways and methods, and in planning and action groups forming at the grass roots, out on the ground." This brings to mind the soil conservation district.

The final chapter is called the "Conclusion" and here is a summing up of farm needs and State and governmental relationships. The real summation is twelve lines from the bottom of the last page in these words: "Whether the device is a new plant or animal, a changed tillage or household method, or a new social mechanism, it has to stand up in the field or be modified in action while it works."

PREVENTION AND CONTROL OF GULLIES. By Hans G. Jepson. U. S. Department of Agriculture Farmers' Bulletin No. 1813. Washington, D. C. September 1939.

"Any gully, no matter how large, and regardless of its condition, will usually be reclothed with vegetation, provided it is properly protected and is in a locality where vegetation will grow." This sentence, and this one, "To prevent the formation of a gully is much better and easier than to control it once it has formed" are chosen from Mr. Jepson's new bulletin as those most suggestive of the practicality and completeness with which the subject is treated. Designed for farmers, the work should prove indispensable to farmers—and to agricultural engineers planning or helping to plan gully prevention or control.

Mr. Jepson is assistant agricultural engineer in the engineering division of the Service, and this bulletin was meticulously prepared in cooperation with other divisions of the Service. The 60 pages are devoted entirely to practical and approved methods for planning complete gully control including proper treatment of the drainage area as well as of the gully itself.

For estimating run-off from a drainage area, a table showing probable run-off from watersheds of various characteristics and acreage is given, along with directions for use. Following this is a discussion of methods for retaining needed run-off, and control of excess run-off by diversion of water from the gully head or by conveying it through a properly protected gully or gully system.

The protection and control of gullies by means of heavy vegetative growth is of course emphasized, with directions for planting and seeding. Special proved woody plants (trees, shrubs, and vines) and grasses and legumes are named and described as to use and methods of planting in gullies. Sod flumes, sod checks, and sodded earth fills are treated in detail with special attention to the transplanting of sod.

The latter half of the bulletin is devoted to structures to be used in gullies to aid in establishing vegetation, or where necessary for permanent protection. Some of these structures can be built by the farmer himself at practically no cost; detailed directions are given and illustrated by drawings and photographs, and types of structures are designated as to material available and size and characteristics of the gully. Temporary check dams to be constructed of wire, brush, loose rock or rough timber, are pointed out for use in gullies that have small drainage areas. Tables are shown for determining probable run-off and the size of rectangular spillway notch required to handle it.

Permanent soil-saving dams are recommended as frequently necessary where gullies must be retained as permanent waterways, to check advancement of large gullies, for water impounding, culverts, etc. Some excellent diagrams show different views of a small rubble masonry dam, a small concrete dam, and the drop-inlet soil-saving dam with square culvert. A table shows drop-inlet culvert sizes required for discharges of 25 to 550 cubic feet per second.

The masonry head flume and the concrete head flume are described and illustrated for use where it is necessary to convey run-off down steep banks or overfalls to a base grade. Jetties for control of erosion of small stream banks are described briefly but in detail; and, finally, some helpful suggestions are given for repair and maintenance of erosion-control structures once they are established to function properly.

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